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Variation and Synonymy of *Phyllaplysia* in the Northeastern Pacific

(Mollusca : Opisthobranchia)

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(5 Text figures)

As a sidelight to a physiological study it has become apparent that *Phyllaplysia zostericola* McCauley, 1960 should be considered as a synonym of *P. taylori* Dall, 1900. *Phyllaplysia zostericola* was separated from *P. taylori* mainly on the basis of the shell and color. McCauley, followed by Marcus (1961), considered the striped, green, shell-less animals that they discussed to be of a different species than the patternless, yellow, shelled animal described by Dall and redescribed by Bergh (1902). It is significant that evidently Dall and Bergh saw only a few long-dead specimens of this organism. Dall gave a very brief, but identifying, description based on "some" specimens sent to him in alcohol by Rev. George W. Taylor from Nanaimo, British Columbia. He described a twenty mm long individual as "a uniform pale lemon-yellow color" and gave its general external features, but he did not mention the shell or the radula. Bergh received one 14 mm long specimen from Dall on which he based his redescription two years later. He agreed with Dall on the color and lack of pattern, described the calcified shell as two mm long, and presented ten figures of the radula and other details. McCauley, working with abundant living material, felt that his animals were different from Dall's, mainly because no shell was evident and there were black stripes which persisted in alcohol even years after the green ground color had faded to yellow.

The following data are presented for the more accurate definition of this species and to provide Steinberg's forthcoming key to the California opisthobranchs with a basis for avoiding the perpetuation of the erroneous idea that *Phyllaplysia taylori* and *P. zostericola* are different species.

Phyllaplysia taylori Dall, 1900

SYNONYMY

Phyllaplysia taylori Dall, 1900: 91-92; Bergh, 1902: 368-370, plts. 26, 27; MacGinitie, 1930: 68; 1935: 739; Smith & Gordon, 1948: 179; MacGinitie, 1949: 377, 380, fig. 236; Steinberg in Light *et al.*, 1954: 264, 268; Ricketts & Calvin, 1962: 250, 461.

Petalifera petalifera taylori (Dall), Engel & Hummelinck, 1936: 54-55.

Phyllaplysia zostericola McCauley, 1960: 549-576, figs. 1-6; Marcus, 1961: 10-12, figs. 27-32; Lance, 1961: 65; Hedgpeth, 1962: 106, plt. 2; Marcus & Marcus, 1962: 453.

MATERIAL EXAMINED

Garrison Bay, San Juan Island, Washington, 10 July 1961, J. Gonor, col., two specimens. Coos Bay, Oregon, August 1962, Lawrence Andrews col., 12 specimens. Humboldt Bay, California, 14 January 1931, G. E. MacGinitie col., 15 specimens; August 1962, Lawrence Andrews col., four specimens. Tomales Bay, California, August 1960, Lawrence Andrews col., one specimen; 31 March 1963, R. D. Beeman, col., 36 specimens. Elkhorn Slough, California, 20 July 1926, G. E. MacGinitie col., one specimen; 27 June 1961, G. L. Reuter col., one specimen; 1961 to 1963, R. D. Beeman col., 800 + specimens. Morro Bay, California, 17 July 1962, Joan Steinberg col., three specimens. Newport Bay, California, 25 July 1955, Nettie MacGinitie col., two specimens.

DISCUSSION

During July 1961, I examined many of these green, striped anaspideans taken from *Zostera marina* in Elkhorn Slough, Monterey Bay, California. Most of these specimens had a shell very clearly visible on the mantle shelf under the left parapodial flap. Figure 1 indicates the appearance of the shell (1.9 by 3.4 mm) on a 55 mm long living animal, and figure 2 indicates its position on the body. The shell is attached ventrally by its convex side to the dorsal surface of the mantle shelf. It is clear, except for a white thickening which is often noticeable around the apex to the left of the shell's center. The shell is almost entirely calcareous (but very delicate) and it therefore disappears in acid stains and sometimes in formalin. This structure is evidently of secondary developmental origin and is, therefore, without a nucleus. There is no trace of a shell chamber.

Further studies in 1962 and 1963 revealed that the presence of the shell is not a constant feature. The shell first appears about March in animals from Elkhorn Slough; its mean size is then much smaller than later in the year and the frequency of its occurrence is low. It is present in the large majority of mature animals by July.

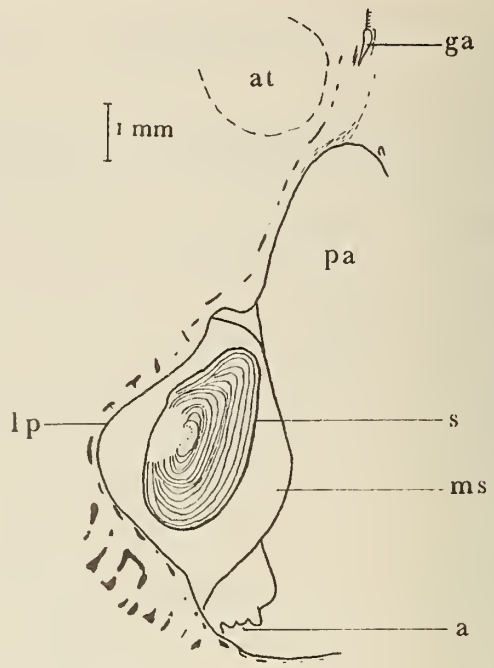

Figure 1: Area of the shell in *Phyllaplysia taylori*. The left parapodium is reflected to show the shell *in situ*.
a - anus at - atrium ga - genital aperture
ms - mantle shelf pa - pallial cavity s - shell

The size of the shell shows little correlation with the size of the animal bearing it. One 30 mm live animal had a 0.23 by 0.15 mm shell; another of the same length had one measuring 1.03 by 0.73 mm. A 33 mm specimen taken from the same *Zostera* blade as the latter one (in Elkhorn Slough, 15 August 1962) had none. Shells were observed in specimens from Coos Bay, Oregon and Humboldt Bay, Tomales Bay, Elkhorn Slough, Morro Bay, and Newport Bay, California. Only two specimens from Washington were available; neither revealed shells when examined.

The presence or absence of a shell does not prevent identification of the animals under consideration with the descriptions of *Phyllaplysia taylori*. Engel & Hummelinck (1936) transferred *Phyllaplysia taylori* to the genus *Petalifera* Gray, 1847 as *Petalifera petalifera taylori* on the basis of the presence of a shell. This is especially interesting since the present article offers the first published illustration of this structure in *Phyllaplysia taylori*. Engel & Hummelinck stated that the genus *Petalifera* is characterized by an aplysiform shell. However, figure 1 shows that the shell of *Phyllaplysia taylori* is distinctly not aplysiform. Marcus (1961: p. 11) states that "a secondary shell without nucleus may exist on the mantle roof of *Phyllaplysia*," and with this I certainly

agree. Such shells are found in at least *Phyllaplysia taylori* Dall, 1900, *P. inornata* Bergh, 1905, and *P. engeli* Marcus, 1955. The available information indicates that the presence or absence of an unenclosed secondary shell is too labile a feature to be used even for the separation of the *Phyllaplysia* of this coast into separate species.

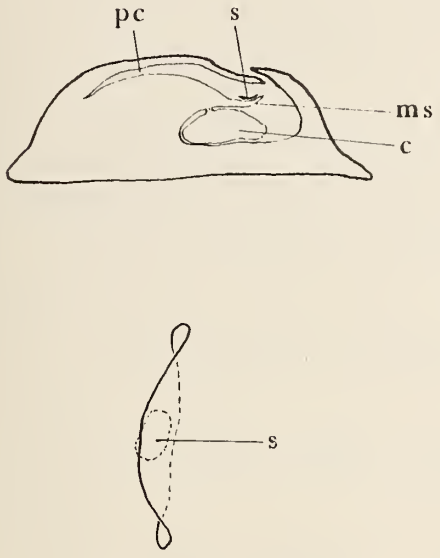

Figure 2: Diagrammatic views (not to scale) of the position of the shell in *Phyllaplysia taylori*.
Upper: transverse section. Lower: outline of parapodia in normal closed position.
c - "ctenidium" ms - mantle shelf s - shell
pc -parapodial cavity

The ground color of the living *Phyllaplysia taylori* is the same bright green as the *Zostera* on which they live. This green fades through olive to yellow in alcohol. The dark brown or black stripes are as described by McCauley (1960: 551-552). As this author observed, these stripes are quite permanent under most conditions of alcoholic preservation. I noted, during oxygen consumption experiments conducted in July, 1962, on Elkhorn Slough animals, that the stripes and green color tended to be lost after the temperature was maintained past the incipient lethal point (about 25° C in this example). Following this lead I determined that similar loss of markings frequently occurred if the animals were allowed to die in seawater before placing them in ethyl alcohol. Animals killed by being placed directly into ten percent formalin lost almost all color and markings in a few months. Since it is impossible to know the conditions of preservation for the specimens which Taylor sent to Dall, the contrast of markings indicated by the original and recent descriptions of this animal must be disregarded. Another observation bearing on this point is that a specimen of *Phyllaplysia taylori* taken in Elkhorn Slough by G. E. MacGinitie in 1926, and at the time of capture presumably of the same green and dark brown color as other animals collected at the same location, now matches Dall's and Bergh's descriptions perfectly, as it has faded to "a uniform pale lemon-yellow color" without any sign of stripes. No living animal of the latter coloration has ever been reported. Future descriptions of color and markings must stress the condition of healthy living animals whenever possible.

Figures 3 and 4 show the appearance of a typical living adult *Phyllaplysia taylori* from Elkhorn Slough, California. The skin of all specimens examined has been smooth and free of any papillose projections. The pattern of stripes is quite variable.

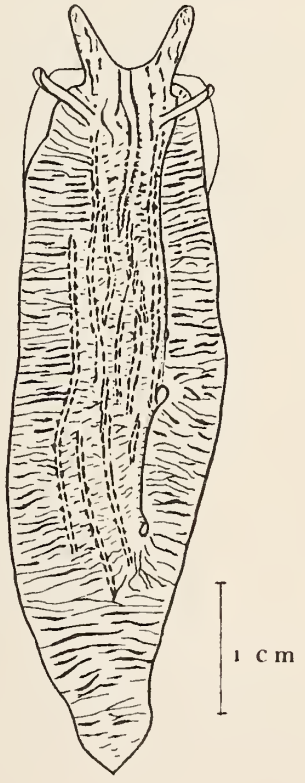

Figure 3: Dorsal aspect of *Phyllaplysia taylori* from life.

McCauley (1960: 550 to 551) felt that the characteristics of the radula served as an additional feature to separate *Phyllaplysia zostericola* and *P. taylori*. He contrasted Bergh's (1905) radula count of 33 rows of teeth

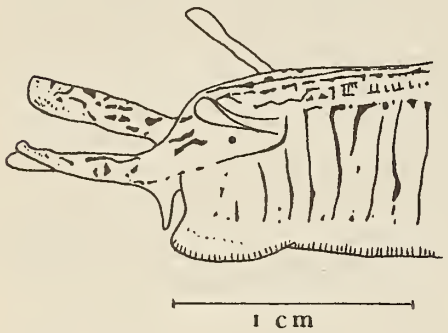

Figure 4: *Phyllaplysia taylori,* lateral anterior aspect from life.

with 32 to 34 lateral teeth on either side of the rhachidian tooth for *P. taylori* with his counts of 40 to 41 rows of teeth with 42 to 52 laterals for *P. zostericola.* MARCUS (1961:11) reported 43 rows with 50 to 53 lateral teeth in the half-row for *P. zostericola.* The key point here is the size of the animal examined. Figure 5 shows the radular counts of 40 alcoholic specimens plotted against the body length. These ranged in size from an individual three mm long and weighing one mg to one 61 mm long and weighing 3.12 gms. The lateral teeth in the half-row ranged from 20 to 61. The number of rows varied from 14 in an 11 mm specimen to 50 in a 61 mm specimen. The number of rows showed only a fair correlation with body length. BERGH described a 14 mm alcoholic specimen; MCCAULEY's type specimen was 50 mm alive, and MARCUS studied a 48 mm alcoholic specimen. Alcoholic preservation of relaxed specimens of this animal results in a reduction of length of about 20 percent from life. The radula counts of the above authors fall on or very near the distinct curve indicated by figure 5.

The radular teeth of all the specimens represented in figure 5 are extremely similar to those illustrated by MARCUS (1961: fig. 31). The teeth illustrated by MCCAULEY (1960: fig. 1) are evidently worn. MCCAULEY (1961: 550, 551, fig. 1) indicates that the rachidian tooth of *Phyllaplysia zostericola* (type locality: San Juan Island, Washington) has three cusps and he contrasts this with the five cusps on the rachidian tooth described for *P. taylori* by BERGH (1902). MARCUS (1961: 11, fig. 31) indicates five cusps for the rachidian tooth of his Tomales Bay specimen. The rachidian teeth of all radulae that I have examined, including two from San Juan Island, have three distinct cusps with an additional hump on each side of the tooth which fades into its base. These lateral rises appear somewhat less distinct than the lateral cusps shown on the rachidian tooth illustrated by MARCUS. Thus it can be seen that the specimens described as *P. zostericola* cannot be separated from *P. taylori* by radular characteristics.

The penis of all specimens examined, including the two from San Juan Island, was armed. The number of papillae on the penis varied from three in a 19 mm alcoholic specimen to 20 in a 52 mm specimen; both of these extremes came from Elkhorn Slough. These structures are usually arranged as two rows of very large papillae on the penis base, which lead into a single row of progressively smaller papillae along the edge of the penis opposite the seminal groove. A few small papillae are scattered out of the rows. A single, hard, cuticular spine is present on each of the larger papillae. The rows on the penis are continued onto the sheath as two rows of at least three large, spined papillae. Four to six small spines are present in the soft folds of the penial sheath.

The hermaphroditic gland is lobate in Elkhorn Slough specimens.

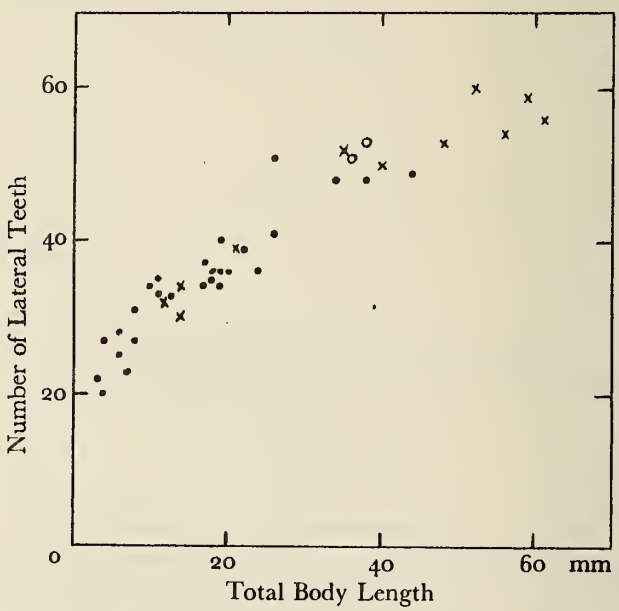

Figure 5: Number of lateral teeth on either side of the rachidian row of the radula compared with total body length of 40 alcoholic specimens of *Phyllaplysia taylori.*
• = Elkhorn Slough o = San Juan
x = Other areas

SUMMARY

Morphological variation in specimens of *Phyllaplysia* from the west coast of the United States between San Juan Island, Washington, and Newport Bay, California, is considered. The present evidence indicates that all the presently known *Phyllaplysia* along the coast from Nanaimo, British Columbia (49° 09′ N, 123° 57′ W) to San Diego, California (32° 42′ N, 117° 11′ W) should be

known under the name of *Phyllaplysia taylori* DALL, 1900.

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